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J. F. KELLY, *Editor*

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— SUBJECTS —

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"Recent Developments in Wet Method of Cleaning Blast Furnace Gas."

"Heating Furnaces for Rolling, Normalizing and Annealing in Sheet and Tin Mills"

"Mechanical Processes for Handling Sheet and Tin Plate."
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b. The Combination System.

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"The Commercial Aspects of Power Factor," J. F. Gaskill, Assistant Manager of Power Sales, Philadelphia Electric Company, Philadelphia, Pa.

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BLUE ROOM, WM. PENN HOTEL — PITTSBURGH, PA.

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"Recent Developments in Alternating Current Motors with Particular Reference to the Auxiliary Equipment in the Iron and Steel Industry," E. W. Henderson, Reliance Electric and Engineering Company, Cleveland, Ohio.

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"Lubrication in Connection with Anti-Friction Bearings," O. L. Maag, Lubricating Engineer, Timken Roller Bearing Company, Canton, Ohio.

CLEVELAND DISTRICT SECTION

FRIDAY, MARCH 25, 1932

CLEVELAND ENGINEERS' CLUB — CLEVELAND, OHIO

A. L. FOELL, Chairman — W. W. SPANAGEL, Secretary

"Electric Welding in Steel Mill Maintenance," James Norman Wilson, Republic Steel Corporation, Buffalo, N. Y.

EDITORIAL

Pioneers in Iron and Steel

FOR seventy years aged men, men in the middle walks of life, young men and boys have struggled, fought, sweated and some died in the battle with earth, water and all of the elements of nature to bring about the present perfection in the art of making iron and steel.

The paths of the pioneers are strewn with the bones of defeat and victory. Some of these men died with their boots on, leaving an inheritance only of personal satisfaction of achievement and accomplishment, others died leaving material success and some are gone, leaving but their names which will live for ages.

The pioneers' lives were filled with endless struggles, yet they moved mountains of ore; they conquered the lakes and the rivers; they dug down deep into the bowels of the earth for the coal; they built, destroyed and rebuilt, all for the joy of perfecting an art, so necessary and so vital that today civilization must first salute them, to pass on.

Today, there towers high into the sky, thousands of smoking stacks, our furnaces light the heavens from coast to coast and vessels ride the high seas to all earth's ports to make steel, the master.

The pioneers have left a heritage which the sons of man must carry on, their banners pinned to the highest flag staffs, their aims and objects to help to make a mightier world, a better place to live in, more peace, more comfort, all built on a foundation of iron and steel.

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MAIN ROLL DRIVE OF 30″–21″ CONTINUOUS MILL AT BETHLEHEM STEEL COMPANY'S LACKAWANNA PLANT

By F. D. EGAN* and C. B. HUSTON†

What is known as number 8 mill in the Lackawanna Plant of the Bethlehem Steel Company has been recently rebuilt and completely electrified. A general view of entire plant shown above. The mill proper is divided into two sections; first the 30″ roughing slab and billet mill consisting of six continuous stands; and second, the 21″ finishing sheet bar and billet mill, also having six continuous stands. The former rolls slabs for a portion of the time which are transferred to other mills in various parts of the plant; but primarily roll slabs and billets for feeding the latter or 21″ mill. Because of this layout of the mills there are separate motor rooms for each, although the oil circuit breaker switching equipments are consolidated in the main motor room at the 21″ mill.

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Both mills are completely electrified and are of special interest because of some new and novel designs or assembly of apparatus and particularly the arrangement of the ventilation applied to the machines and to the station as a whole.

The six stands of the 30″ roughing mill are grouped in pairs, each driven by a separate synchronous motor through tandem reducing gear units. These motors are: For stands 1 and 2, one 2500 HP.—125 R.P.M. motor; for stands 3 and 4, one 300 HP.—187.5 R.P.M. motor; and for stands 5 and 6, one 3500 HP.—300 R.P.M. motor. Each is a three phase, 25 cycle, 6600 volt unity power factor, 40 deg. C. machine.

The six stands of the 21″ finishing mill are driven by individual direct current motors, also through reducing gear units. The motors for stands 1 and 2 are each rated 1500 HP.—40 degree—150/300 R.P.M. and for stands 3, 4, 5 and 6 are each rated 2500 HP.—40 degree—200/400 R.P.M. Power for these motors

is supplied by two 4000 Kw. synchronous motor-generators, each consisting of two 2000 Kw.—600 volt, direct current generators direct connected to and mounted on a common base with one, 4350 Kva.—unity power factor—500 R.P.M.—3 phase—25 cycle—6600 volt, synchronous motor.

HIGH TENSION SWITCHING EQUIPMENT

Power for these mills is brought into the motor room of the 21" finishing mill through four type FH-303-B—1200 ampere oil circuit breakers, which form a part of a 6600 volt—25 cycle—3 phase loop system, extending throughout the plant.

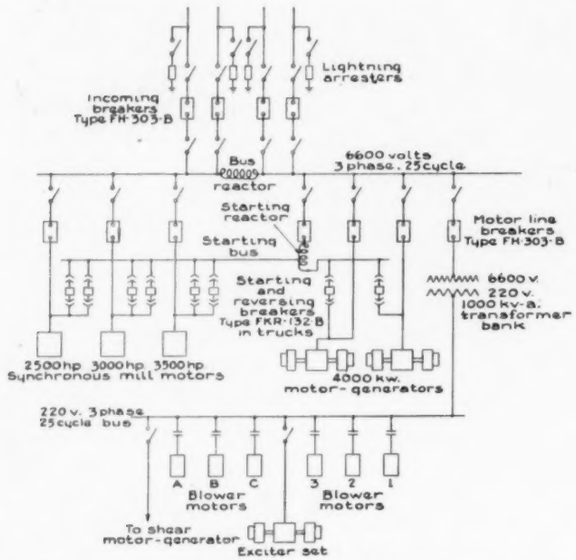

FIG. 1.—Alternating Current Distribution and High Tension Switching Equipment for the 30" Roughing and 21" Finishing Ends of the No. 8 Mill at the Bethlehem Steel Co., Lackawanna, N. Y.

Fig. 1 shows diagrammatically the connections of the switching equipment within the station. Each incoming line is protected by a lightning arrester. A bus reactor is inserted between each pair of incoming lines and thus becomes a part of the loop. A study of short circuits was made prior to this installation which showed that reactors inserted within the loop proper would serve the most useful purpose of protection to the system as a whole. In this manner the reactor helps to limit the current into faults outside as well as within the station.

There are seven additional type FH-303-B oil circuit breakers used for main line or running breakers serving the main mill synchronous motors, motor-generators, transformer bank, and starting reactor. These are all mounted on a gallery and may be clearly seen at the right foreground in the general view of the station, Fig. 2.

For starting the synchronous motors there is a common starting bus which is connected to the main bus through a starting reactor. This starting bus is divided into two sections, one for the motor-generators and one for the synchronous mill motors, which may be connected to different taps on the reactor. A higher voltage tap may in this way be chosen for the mill motors which will provide for them the proper torque for starting the mill. A lower voltage tap may accordingly be chosen for the synchronous motors of the motor-generators on which only a small amount of starting torque is required.

All of the starting breakers are type FKR-132-B mounted on trucks and housed in steel enclosures. These are assembled together with the bus and starting reactors on the main floor of the motor room underneath the gallery. Metal doors have been provided for enclosing the compartments in which the reactors are placed, which match in general appearance the metal front on the trucks.

FIG. 2.—General view from south end of the 21" Finishing Mill Motor Room. The Incoming Line and Main Motor Oil Circuit Breakers of the Type H, Mounted in Cells, are shown in the foreground assembled on a gallery.

For reversing the synchronous motors on the 30" mill to back out a cobble or to plug the machines to bring the mill quickly to rest, separate reversing breakers connect the motors to the starting bus only. It is not the intention that the motors be brought to full speed and synchronized in the reverse direction, but that the mill simply be jogged if reversing at all be necessary. With this service in view a small breaker the same size as that used for starting may be applied, thus saving the increased expense of a high capacity type FH-303-B, such as used for the main oil circuit breakers.

All starting or reverse breakers are interlocked to prevent the possibility of getting more than one closed at the same time, and in this way overloading the starting reactor is prevented. The reactor, however, has ample capacity to withstand the starting of all three synchronous mill motors and the two motor-generators in quick succession several times.

The starting of all of the synchronous motors is fully automatic after the impulse has been given by the operator in closing the starting control switch. The motor accelerates to approximately 95% of synchronous speed, field is applied, the machine synchronized, and finally placed on the line by the closing of the line breaker without any personal attention. The motors on the 30" roughing mill are started from the control board in the 21" finishing mill motor room by the station operator, at signal from the rollers. The latter, however, have the means of stopping the mill from control switches on an instrument pedestal conveniently located in the mill.

A 1000 Kva.—6600 to 220 volt transformer bank

serves station auxiliaries as well as a few A.C. operated auxiliaries in the mill. This bank consists of three 333 Kva. oil-cooled transformers located in a vault on the main floor, under the gallery. This vault is sealed from the main room except through a door which is normally kept shut. Ventilation of the transformers is afforded through louvers placed in the outside wall. This arrangement of installation has been adopted in general by the Bethlehem Steel Company for low voltage indoor transformer banks, and prevents the spreading of burning oil to other parts of the station in case of serious trouble with the transformers.

The main alternating control board is located on the main floor in a specially constructed back-to-back assembly with the synchronous motor field and station auxiliary control panels. These are clearly shown in the right foreground in the view of the motor room, Fig. 3. There is sufficient clearance between the front and back row of panels to give free access to the back of the boards. The top has solid sheet metal covers and the ends are equipped with grill work doors. The back of the panels are thus enclosed and all connections are well protected.

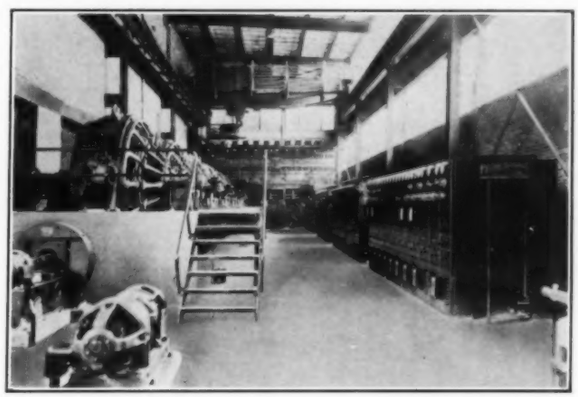

FIG. 3.—View showing the six Direct-Current Mill Motors of the 21" Finishing Mill. The Alternating Current Vertical Control and Station Auxiliary Boards Mounted in a Back-to-Back Arrangement are shown in right foreground.

Artificial lighting is provided within the enclosure, so arranged that all parts at the rear of the panels are well illuminated.

The main A.C. control panel embodies all meters, relays, control switches, etc., for the incoming lines, transformer, and synchronous motors. The impedance type of overload relays has been used for the incoming lines while the usual inverse time type of induction relays has been used for protection on the various motor and transformer circuits. Curve drawing watt meters are provided for each of the synchronous motor circuits. Watthour meters are provided for all circuits.

The panels at the rear of the assembly comprise the field control equipment for the synchronous motors, the 220 volt A.C. control for the exciter set, the blowers, the heater circuits and feeder for the motor-generator used with the shear equipment. All of these auxiliaries except the latter are started at full voltage. Line contactors with thermal overload relays are used for each blower motor but in order to assure continuity of service in the most reliable way, the exciter is tied solidly to the low voltage

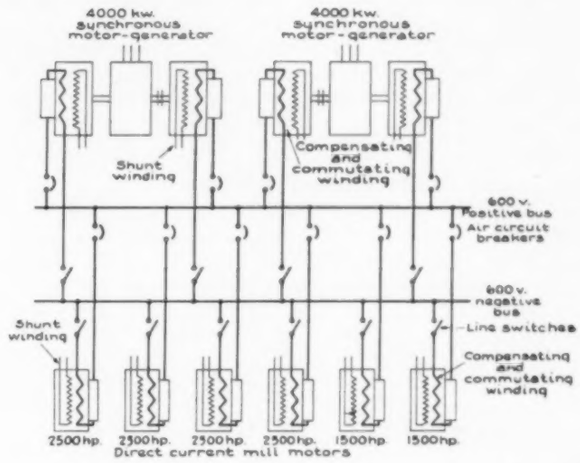

FIG. 4.—Connections of the 600-Volt Direct-Current Generator and Motor Main Line Circuits for the 21" Finishing Mill Motor Room.

bus through triple-pole line switches. These sets start on full voltage by the closing of the main high tension oil circuit breaker and continue to run so long as the transformers are energized.

DIRECT CURRENT SWITCHING EQUIPMENT

Each of the direct current generators and motors is tied to the 600 volt bus with an air circuit breaker in the positive side and a line switch in the negative side (see main armature connection diagram Fig. 4). The direct current switchgear panels have been assembled in two groups, the air circuit breakers being in one group and the line switch together with the control switches and meters being assembled in another group. This arrangement is shown to best advantage at the left foreground of the general station view, Fig. 5. The positive and negative buses are mounted separately above the tie rods on each respective group of panels. The separation of the buses has reduced the hazard of break-down from one to the other and has made it possible to utilize greater clearance to ground on the 600 volt interconnections at the rear of the panels.

The meters and control devices for use with the direct current machines are mounted on the lever-

FIG. 5.—General view from the north end of the Motor Room for the 21" Finishing Mill Motor Room. Five of the six Direct-Current Mill Motors are shown Mounted on a Raised Portion of the Motor Room.

switch panels. For each generator there is a line ammeter, back-of-board field switch, air circuit breaker control switch, and field rheostat control switch. For each motor there is an indicating line ammeter, curve drawing ammeter, back-of-board field switch, and field protective and counter-E.M.F. relays.

Control of Direct Current Machines:

The elementary connection diagram, Fig. 6, shows the field connections of the direct current motors and generators forming the main drive of the 21" finishing mill. Excitation is normally provided by a 250 Kw.—250 volt compound wound motor driven exciter. A double-pole, double-throw lever switch permits the excitation bus to be transferred from the exciter to the 250 volt mill supply circuit in case of trouble with the former. There is no overload protection given to the exciter, it being rigidly connected to the bus through this lever switch.

Because of the size of the motors and the large and expensive magnetic starting equipment required for the usual resistance method of starting, the Ward Leonard method of starting is used instead for the six finishing mill stands. All motors are started simultaneously by gradually building up the voltage on the direct current generators. The fields of the four generators are connected in parallel, and are supplied from a separate section of excitation bus. This separate section of the bus is connected to the main 250 volt excitation bus through a motor-operated reversing potentiometer field rheostat. The voltage of the generators may therefore be controlled in either direction from zero to full value (600 volts). It is seldom necessary to reverse the mill but the reversing feature is nevertheless an essential requirement and may be used in emergency to back out a piece from the mill.

There is a motor-operated rheostat in the field circuit of each generator by means of which the excitation on each machine may be adjusted for proper parallel operation of the several machines. These rheostats are under control of the station operator only and are usually adjusted for proper division of the load at about normal rating and then left in this position.

The generators are shunt wound, no series or compound windings being provided. Difficulty is usually encountered on such systems if an attempt is made to use a normal compound wound generator because, at the very low voltage required for starting the motors, the series field so strongly predominates over the shunt field that the heavy initial inrush starting current produces an unstable voltage condition. For this reason the generators have been made shunt wound and, being separately excited, are stable at all adjustments of voltage for starting as well as running the mill.

In order to overcome the inherently drooping voltage characteristic of straight shunt wound generators, a voltage regulator is used to maintain constant voltage at the bus. This is built in the form of a counter-E.M.F. type of regulator, the counter-E.M.F. machine forming a part of the exciter motor-generator. The armature of this machine is connected between the main excitation bus and the potentiometer field rheostat through a double-pole, double-throw transfer switch mounted on the regulator panel. The contacts of the regulator operate across the field of the counter-E.M.F. machine which is separately excited from the main excitation source. The main coil of the regulator is connected across the 600 volt bus. A high voltage on the bus will cause the regulator contacts to open, removing the short from the field of the counter-E.M.F. machine. This will raise the voltage of the latter which, as previously stated, is connected in opposition to the main excitation voltage, and thus reduce the field current on the generators, resulting in a lower voltage at the bus. If the voltage at the bus falls too low the regulator spring over-balances the main operating coil and the regulator contacts are caused to close. This will short the field of the counter-E.M.F., and allow the field current of the generators

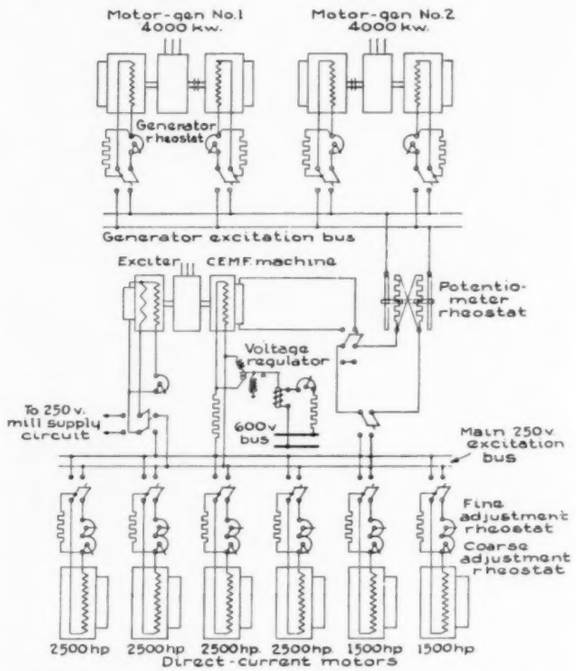

FIG. 6.—Connections of the Field Circuits for the Direct-Current Generators and Motors for the 21" Finishing Mill Motor Room.

to increase, thus raising the voltage at the bus. An anti-hunting feature, not shown in the elementary field control diagram, Fig. 6, causes the regulator contacts to vibrate rapidly, thus regulating the voltage at the bus to a constant predetermined value. This value is normally set at 600 volts and, to permit fine adjustment in this respect, a small hand-operated rheostat is connected in series with the regulator coil and mounted on the regulator panel.

When starting or stopping the mill motors through the control of the generator voltage, the voltage regulator will tend to counteract the operation of the potentiometer field rheostat, and will be successful in this respect until the regulator runs out of its range of control. This range is usually limited to about 10% above and below the normal operating value, 600 volts. Thus when beginning to reduce the bus voltage by means of the potentiometer rheostat no results are obtained until the regulator goes out of range. The regulator will then stand with its contacts closed, ready to start operation as soon as the mill is restarted and bus voltage is built

up to within its range of control. The control of the potentiometer rheostat is arranged so that it runs to the full voltage position each time the mill is started, and the regulator thus automatically comes into play without personal attention or extra manipulation on the part of the operator.

This direct current control equipment is thoroughly interlocked in order to protect the machines in case the operator does the wrong thing in the handling of his controls. For instance, the generator or motor air circuit breakers cannot be closed unless (1) the corresponding field switch has been closed to provide excitation to the machines; unless (2) the potentiometer rheostat is in the off or zero voltage position; unless (3) the contacts of the bus voltage relay are closed indicating zero voltage on the bus. Furthermore, in case of the motor breakers, there is further protection to prevent them being closed unless (1) the counter-E.M.F. voltage of the respective motor has fallen to a very low value; and unless (2) there is field on the motor indicated by field protective relay. Each motor-generator and direct current motor is equipped with speed limit switches which control the tripping of the air circuit breakers and protect the machines from excessive speeds.

For controlling the speed of the mill motors above their basic or full field value, there are two motor-operated field rheostats, one giving coarse adjustment, covering the full range, and the other giving fine or vernier adjustment for obtaining accurate speed setting. In order that the operator may know in what position the vernier rheostat is with reference to its limit of range, it is equipped with a selsyn indicating device. This consists of a selsyn transmitter geared to the vertical screw of the rheostat and a selsyn receiver carrying a pointer and dial mounted on the bench board in the operator's pulpit.

The settings of the field rheostats controlling the speed of the mill motors are not disturbed when the mill is shut down. No attempt is made to strengthen the field of the motors for starting. Sufficient starting torque is obtained, without drawing excessive load current, even though the motor fields may be adjusted for a high speed setting. In this way the motors will automatically come back to the same speed as that at which they were previously operating, when the voltage has been restored to normal.

Pulpit Control for 21" Finishing Mill:

The control of the 21" finishing mill providing starting, stopping, reversing, and speed control of the several direct current motors is consolidated on a special benchboard in the operator's pulpit which overlooks the mill. There are seven sections on this benchboard, each 14" wide, giving a total assembly of 8'2".

Each section is made by welding together a framework to which the back is solidly welded in place. The front is fastened with bolts so as to be removable if desired. The top on which the control switches and similar devices are mounted is hinged. By means of these special hinged tops, which may be raised to a nearly vertical position, the backs of the control switches and all wiring are made easily accessible.

The control for two motors is grouped on each section and all switches are equally spaced, giving seven inches between centers of the control for each motor. In this way the control of the whole mill is consolidated for the greatest convenience to the operator. Each motor control embodies a control switch for the vernier field rheostat, a control switch for the coarse adjustment field rheostat, a control switch with indicating lights for the main air circuit breaker, and a selsyn indicator for showing the position of the vernier rheostat with reference to limit of travel in either direction.

These vernier rheostats have been made remote controlled, motor operated in order to overcome the construction difficulties of mounting hand-operated rheostats at the benchboard or under the floor of the pulpit. With the removal of hand levers, wheels or other manual operating devices, the space required for each motor control can be minimized.

Two sections of the benchboard are reserved for the control of the generators, and these embody one control switch with indicating lights for each generator air circuit breaker, one common control switch used for simultaneous tripping of all generator breakers, one control switch for controlling the reversing potentiometer rheostat by which the whole mill is started and stopped, and one other control switch used for operating a signal to the operator back in the motor room.

On the benchboard are also located the control switches governing the electrically operated loopers and the motors driving the edger rolls. The edger mill motor controls, which comprise control switch with indicating lights for starting and stopping the edger motors through their magnetic control equipment, and control switch for electrically operated field rheostat, have been interspersed between the controls of the main motors in the same order as the edger rolls are located in the mill.

The meters which are useful to the operator in controlling the mill are mounted in an enclosed cabinet with glass doors placed some distance above the benchboard. For each main and edger motor there are an ammeter indicating load current, and a tachometer indicating motor speed. For each generator there is a line ammeter, and for the group of generators one voltmeter which is connected to the 600 volt bus. Artificial illumination is provided within the cabinet to assure good visibility of the scales of the instruments.

The electric tachometer equipment with which each main and edger motor is equipped, consists of a small direct current generator geared to the shaft of the main machine, and voltmeter operated from the generator and calibrated in terms of revolutions per minute of the mill rolls. The fields of the generators have been especially wound so that all fields may be connected in series and excited as one circuit from the 250 volt excitation bus. There are an ammeter and a field rheostat in this circuit, located in the pulpit as a part of the benchboard equipment, with which the operator may adjust the excitation of the tachometer generators to the proper value. With this arrangement quite accurate speed indication is obtained.

VENTILATION

In the design of present day electrical apparatus and the stations in which it is installed, more and more attention is being paid to the subject of ven-

tilation. Ventilation is important to keep the apparatus clean, as well as cool. As first applied, the prime motive was to keep the apparatus cool, but experience has indicated the equally important necessity of keeping the machines and station clean. The mills are inherently smoky and dirty places. There is always a great amount of carbon, soot, and gases floating in the air.

Natural ventilation afforded by leaving doors and windows open and depending upon the chimney effect set up within the walls of the building for interchanging the air within, no longer suffices for carrying away the large amount of heat losses which we find concentrated within the motor rooms for some of the more recent rolling mills. Forced ventilation by directing the air through the machines is effective for carrying away the heat losses, but it does not provide for keeping the apparatus clean. In fact, quite to the contrary; experience has shown that a motor to which forced ventilation has been applied without an effort to clean the air will accumulate far more dirt than one operating as an open self-ventilated machine. Therefore, it is not only important to provide a sufficient quantity of well directed cooling air, but it must also be well cleaned.

Another important phase of the ventilating problem is to maintain an ambient temperature within the station which will be comfortable to the operators. Even though air may be brought in from the outside, filtered and forced through the machines, all of the heat losses will be liberated into the room. It is true that some provisions must be made to carry the warm air out of the room, usually through ventilators in the roof, but nevertheless the ambient room temperature soon reaches the same temperature as that of the warm air being discharged from the machines. In the design of this equipment, as well as the station itself, all of these facts were taken into careful consideration.

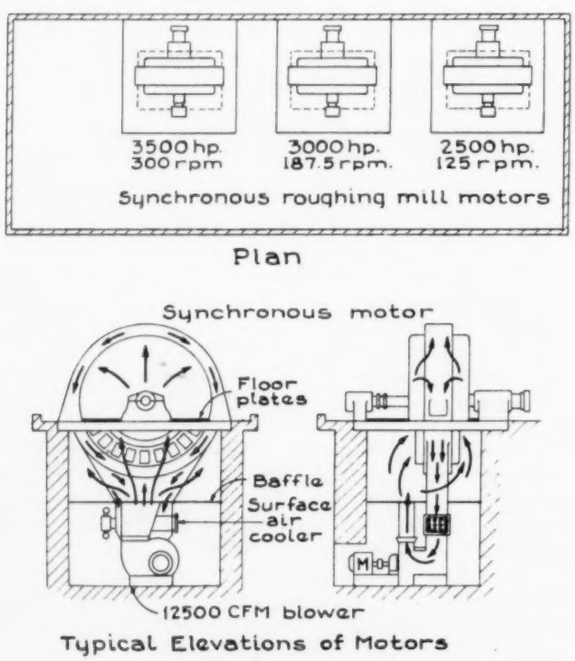

FIG. 7.—Plan of Station and Sections Through Motor which shows the Arrangement of recirculating Ventilating System as Applied to the three Synchronous Mill Motors on the 30" Roughing Mill.

Ventilation of 30" Roughing Mill Motors:

Each of the three synchronous motors on the 30" roughing mill is equipped with special enclosing covers arranged so that air may be brought from the pit into the machines at either side of the rotors and discharged through a separate duct attached to the bottom of the stator frame. A surface type of air cooler is placed in this outlet duct through which the warm air passes. Below the cooler a motor-driven fan is located with its intake connected to the outlet side of the cooler. The discharge side of the fan is then connected by a separate duct back up to the intake section of the pit directly under the motor. Each motor with its ventilating equipment therefore constitutes a self-contained, enclosed cooling and recirculating system, installed all within the walls of the foundation for the machine.

Fig. 7 illustrates how this ventilating equipment has been applied. An attempt has been made to place the arrows so they will show how the cool air is forced by the blower upward through the pit into the machine, and how the warm air is collected in the stator frame and drawn downward through the surface cooler. Water is used as a cooling medium and thus the heat losses are carried away without being liberated to the room, save those which radiate directly from the frame and the bearings of the motor. Since the system is entirely enclosed and the air within is recirculated, there is no chance for the accumulation of dirt, and the inside of the machine is kept very clean.

Ventilation of 21" Finishing Mill Motor Room:

Because of the nature of the construction of the machines, the number involved, and especially because of the importance of keeping the air within the room clean and cool, it was not practical to treat the ventilating problem of the 21" finishing mill motor room in the same manner as applied to the motors of the 30" roughing mill. The construction of direct-current machines does not readily permit the use of an individual recirculating scheme. The number of machines involved would not make such a scheme economically practical and, besides this room being the main substation for the whole mill where an attendant is always present, there was greater need of keeping the air within the room clean and cool. A recirculating system was therefore applied to the station as a whole which can best be described by referring to the drawing of plan and elevation represented by Fig. 8.

The direct current mill motors are constructed with enclosing covers on the coupling end, and are arranged to receive air delivered to them from the pit underneath and to discharge the air out over the commutator into the room. The motor-generators are equipped with special volute housings on the generators and with especially constructed shields and openings in the stator frames of the synchronous motors so that air is taken into the machines from the room and discharged into the basement.

It will be observed by referring to the plan of the station (Fig. 8) that the motors are placed at one end of the room and the motor-generators at the other. The basement, it will be further seen, is divided into four compartments—A, C, D and E.

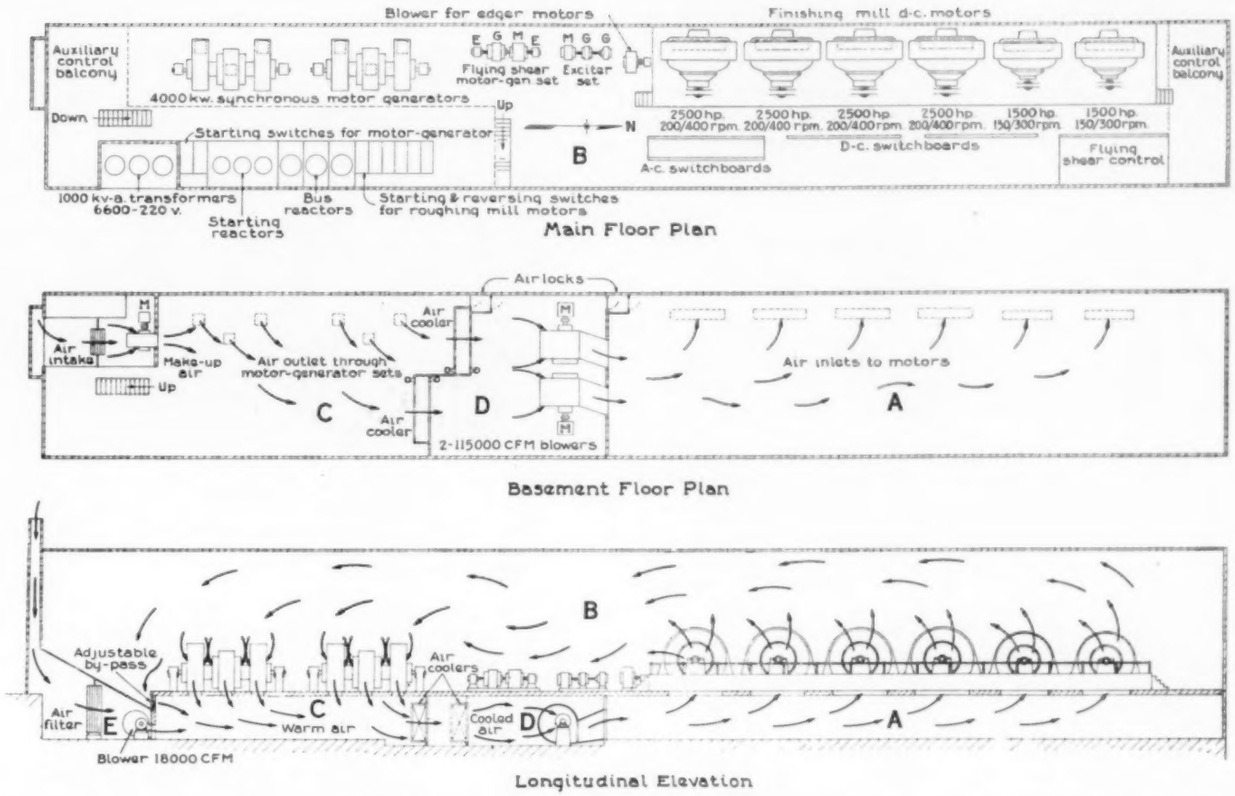

FIG. 8—Plan and Section of the Motor Room of the 21" Finishing Mill Motor Room. This drawing shows how the Air Circulates from one Compartment to another and through the machines in the Recirculating Ventilating System applied to this Station.

Two motor-driven blowers are located in compartment D. Surface air coolers are installed in the partition between compartments C and D. Air is accordingly recirculated, being set into motion by the blowers. It is delivered into chamber A under pressure whence it finds its way up through the motors into the main room B. From the main room the air is picked up by the motor-generators and delivered into the basement at chamber C. Thence it is drawn by suction of the blowers through the surface coolers back into the chamber D.

All doors and windows in the motor room are kept tightly closed but, to make sure there is no leakage into the room of air from the mill or out-of-doors carrying with it dirt or soot from outside, the whole system is maintained slightly above atmospheric pressure by a separate intake blower located in the end of the basement at chamber E. Here, outside air is brought down the stack at the end of the building through filters and delivered into the chamber C at a slight pressure, about 2.5 inches water gauge. This make-up air equipment is also needed in this particular case in order to supply a continuous drain caused by a small blower located in the main room for supplying ventilating air which is piped to the edger roll motors located in the mill. The blower for the make-up air supply is rated 18,000 cubic feet per minute at 2.5 inches water gauge, being close to 10% of the combined capacity of the two main blowers. The filter is the Reed multi-panel oil screen type having the same capacity as that of the make-up blower.

The series system of forcing the air first through the motors and then through the motor-generators was chosen because it was the most economical from the standpoint both of the cost of construction of the machines and of the cost of operation, and besides results in reasonably low ambient temperature within the main room. From the latter standpoint, it would be preferable to use a parallel scheme forcing all the cooled air directly into the room and then to equip the mill motors with volute housings similar to those on the generators, but the close centers on which the motors had to be installed did not permit the use of such housings and besides they would have been much more costly than the present form of enclosing shields.

An alternative scheme would have been to force air up through the motor-generator into the room in the same manner as through the mill motors. This would have liberated the losses of all of the machines into the main room, resulting in a high ambient room temperature which is one of the objectionable features of the ordinary system of ventilation. With either of these two parallel schemes larger blowers would be needed to handle nearly double the volume of air, although at somewhat lower pressure. The cost of them would be equally as great if not greater, and the physical size such that more expensive construction of the basement would be needed in order to house them. Also the

size of the coolers would be greater—and consequently more expensive—to accommodate the passage of the greater volume of air. Therefore, all things considered, the scheme of passing the air through the various machines in series proves to be more satisfactory. This is true of course if the combination of motors and motor-generators is such that they about balance in the amount of air needed, as they were in this particular case.

The two main blowers are each rated 100,000 cubic feet per minute at 4-inch water gauge pressure. They are especially designed so as to be non-overloadable, having characteristics shown by the curve

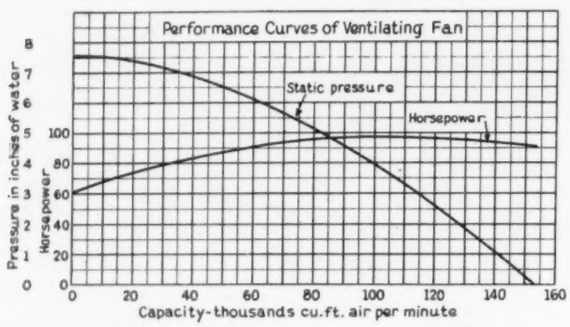
Performance Curves of Ventilating Fan
Static pressure
Horsepower
Pressure in inches of water
Horsepower
Capacity-thousands cu.ft. air per minute
0 20 40 60 80 100 120 140 160
0 1 2 3 4 5 6 7 8
0 20 40 60 80 100

FIG. 9.—Characteristic curves of the Main Blowers used in the Ventilating System of the 21" Finishing Mill Motor Room.

in Fig. 9. All air ducts, dampers, etc., are designed to handle the combined capacity of both blowers, but one fan will take care of the ventilation of the station under normal operating conditions. With only one blower in operation, the resistance drop through the various ducts and passages through the machines is lower than with both blowers in use. From the characteristic curves it will be found that at 2.5 inches pressure, to which the resistance drop will fall, one blower alone will deliver 120,000 cubic feet of air per minute, and this will be accomplished without requiring any greater power input per blower than when delivering a lesser volume at higher pressure.

In the pits of each motor there are air barriers for directing the air through the machine. In these barriers there are slides which may be opened slightly if necessary to allow some air to bypass directly into the main room. Back of the main switchboard directly under the field rheostats there also are some additional bypass openings, all of which assure first that the full amount of air is circulated and second that there are no hot spots in which there is not a free circulation of air. At the motor-generator end of the room some sliding louvers have been placed in the door connecting the main room to the section of basement under the motor-generators. By adjusting these louvers the amount of air circulated may be controlled. In case the motor-generators will not handle the full amount, some air may accordingly be bypassed around them.

Water from Lake Erie is used as a cooling medium. It is necessary to have water for the rolls in the mill, and the same water can serve both purposes. The pressure drop through the coolers is small, being about 15 lbs., with a maximum flow of 800 gallons per minute. The pumping of the water is therefore not an appreciable item of cost of operation.

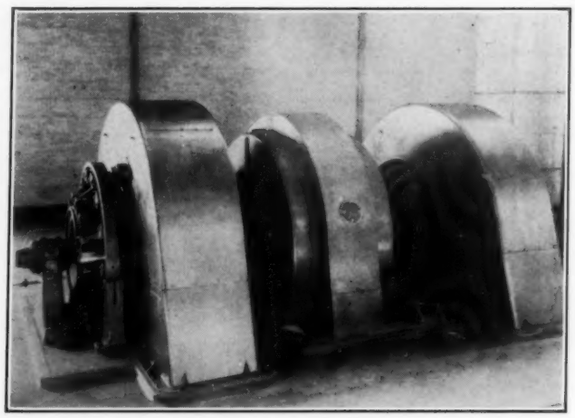

FIG. 10.—Close-up view of a Motor-Generator showing General Construction and Method of Assembly of the Volute Housing with which each of the four Generators are equipped in the 21" Finishing Mill Motor Room.

The maximum temperature of the lake water taken over a period of years is 70°F. It is expected that with the surface coolers the ventilating air may be brought to within 10° of the temperature of the cooling water. With one blower in operation delivering about 120,000 cubic feet of air per minute, the energy exerted in raising the pressure of the air will cause about 2°F. rise in the air itself. On this basis the air delivered to the motors will be at 82°F. Under the normal operating schedule of the mill the heat losses of the motors will raise the air to 97°F. This will be the temperature of the room which, although warm, is not uncomfortable to the operator and still is within limits for satisfactory ambient temperature for the motor-generators. The air when passing through the motor-generator will increase about 16°F. giving a temperature of 113°F. in the section of the basement under the motor-generator. High temperature here is not objectionable to either machines or operators. With both blowers in operation, circulating the maximum volume of air 200,000 cubic feet per minute, the temperature of the room may be held to 92°F. on the warmest summer days, which may be even lower than that outdoors.

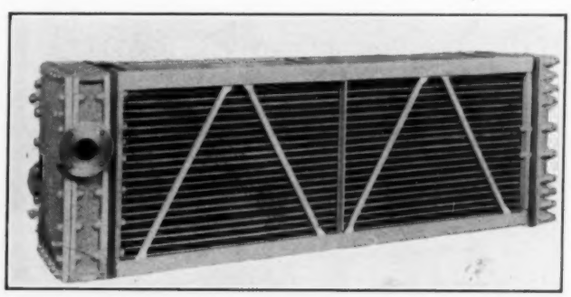

FIG. 11.—Surface Air Cooler of the type used for Cooling the Air in the Recirculating Ventilating Scheme.

The one special feature in the design of the machines which has made possible a recirculating sys-

tem of the type just described for the 21" finishing mill motor room, is the volute housing with which each of the generators is equipped. The general construction of the housings and the manner in which they are assembled on the machines are clearly shown in (Fig. 10). The width is slightly greater than the length of the armature along the windings, and the sides come down close to these windings at either side of the machine. The shape of the housing is in the form of a volute similar to that of a blower. It is assembled on the machine in the proper relationship to the direction of rotation so that the air set in motion by the fan action of the rotating armature is collected within the housing and discharged at the large end of the volute. As a result, the generators are converted into blowers and made use of for exhausting air from the station. They are essential in this particular installation in keeping the air in recirculation.

Fig. 11 is a photograph of a surface air cooler of the type used for cooling the air in these recirculating ventilating schemes. The cooler is made up of a large number of copper tubes assembled between two rectangular cast heads. The cooling water is brought into one side of the connection head, passed through one-half of the tubes to the head on the opposite end, and then passed back through the other half of the tubes to the outlet compartment of the first head. The steel frame joining the two heads is so constructed that several sections may be stacked one on the other, and so that they can readily be framed into a wall or duct for controlling the passage of air through them. For each of the synchronous motors on the 30" roughing mill one section was used, and for the 21" finishing mill six sections were required, assembled in two groups of three each. In order to increase the efficiency of heat transfer a fin in the form of a copper strip is wound edgewise spirally around the tubes.

The main drive motors, motor-generators, and switchgear equipment were built and installed by the General Electric Company.

A DISCUSSION OF UNIFORM METHODS OF MEASURING FUEL EFFICIENCIES

Quite a number of Combustion Engineers have offered the suggestion that the Combustion Engineering Division of the Association of Iron & Steel Electrical Engineers include in their future programs A STUDY OF A UNIFORM METHOD OF COMPARING FUEL EFFICIENCY RECORDS BOTH FOR HEATING FURNACES AND BOILERS.

A prominent Combustion Engineer offered the following letter in connection with this subject, which in turn was submitted to a large number of Combustion Engineers for their analysis of this subject.

The letter and the replies are submitted herewith. Both the letter and the replies indicate that the subject is worthy of serious consideration by the Steel Plants.

"Replying to your letter of September 30, relative to suggestions for the Combustion Engineering Division of the Association of Iron & Steel Electrical Engineers, would say that I have discussed this with our Engineering Department and we feel that one of the most valuable contributions of the Association would be the submission of a method of comparing fuel efficiency records, both for heating furnaces, as well as boilers.

"In explanation would say that we have found in our visits to other plants and in discussions of fuel matters in the several meetings that there is a considerable difference in methods of reporting efficiencies and in factor; i.e., pounds of coal, gross B.T.U., net B.T.U., efficiencies for short periods or monthly efficiencies, gross or net with various methods of arriving at auxiliary steam allowances, units of cost value; i.e., B.H.P. month or cost per 1,000 pounds of steam, etc., which makes comparison difficult.

"Naturally, each plant thinks their own method is most satisfactory and it would be difficult to change methods of accounting but if a suitable questionnaire were sent out to all plants it would be possible to find out what methods were generally used and possibly a standard form suggested that could be incorporated in the persent records for comparison with other plants by those in a position to obtain the figures.

"You will realize that we believe we have at some of our plants very efficient units, but we do not have any way of finding out whether we are as good or better than similar plants of other companies, and we have heard of results at other plants which are apparently so good as to be worth investigation, but we have not sufficient data as to the method used in calculating efficiencies and as a result we question them.

"While this subject is difficult to handle, I believe that a committee of fuel and steam engineers of our Industry could obtain by a questionnaire sufficient data to determine the probable value of such a standard.

"I believe that our Association could help the Steel Industry by submitting a standard method of reporting fuel and steam efficiency data."

▲

ANSWERS TO ABOVE LETTER

1. "The above subject is one of many in which the writer is extremely interested. Since the year 1914, when we started in the Combustion Engineering work, we have been interested in establishing systems of accounting, wherein we could compare present with past performances and compare the combustion work in plants of similar characteristics with the plant with which we were most interested, in so far as fuel efficiencies were concerned.

"During the past eighteen years we have always kept in mind that one of the duties of the Combustion Engineer was to act as a B.T.U. auditor, and our work has always been toward that ideal, in which we could show to those interested, not only the cost of the fuel used in any individual plant, or division, but how each B.T.U. was used in relation to the efficiency of its use.

"We have, in the last five or six years, developed this idea still further to the extent that we now are able to have a B.T.U. Audit in our plant, so that we can strike a balance at the end of the month, the week, the past twenty-four hours, or the operating turn of eight or ten hours, and by heats in the Open Hearth. The figures of the individual furnaces, of course, are balanced with the input of B.T.U.'s to the plant, during a like period and the transportation losses determined.

"Indeed we find great satisfaction in an arrangement whereby each furnace B.T.U. consumption per ton of product heated is reported to the operating superintendent of that department at the end of each turn, within a few minutes after the end of that turn operation. In this way we are able to control inefficient operation of individual furnaces at the time such operation is occurring, and have been able in that way to reduce the expense of our operations to a marked degree.

"It so happens that this Plant is fortunately situated in a district where our fuel supply is fuel oil, by-product coke oven gas or natural gas, and it is not difficult for us to measure accurately the input to the plant or the input to the individual furnaces. It is, however, necessary that we keep our measuring instruments in good condition and while we spend a lot of time on this work, we believe it has been justified in the final results.

"When we began to compare the B.T.U. results in our Plant with the other Plants we found it necessary to make certain corrections, or adjustments, because of different fuels in use in the other divisions.

"To shorten a long story, may we say the final arrangement was a use of net heating values of the various fuels in the different Plants. By this net heating value, we have been able to make corrections for the various efficiencies of gas producers, for the different hydrogen values of fuel oil, coke oven gas, and the different heating values of the natural gases used in the other Plants, and for the different methods of using coal, either direct fired or gasified.

"We now believe that we have a fairly accurate comparison of the Plants so that, in so far as the fuel itself is concerned, we can compare the operation of one Plant with another. These reports are exchanged monthly showing the B.T.U. consumption of each individual furnace in each Plant on a net heating value basis, and as each furnace in the different Plants are different in their construction and their methods of operation, in order that we can see how well each furnace does, compared to what it should do, the Plants have set up ideal standards of Million B.T.U. per ton. This also has been a great help in giving us something to shoot at.

There are some items of minor nature which effect the ultimate accuracy of fuel audit for comparison of different plants. These include the rate of operations, the type and kind of material produced on the different units, such as a quality Open Hearth shop compared to a tonnage Open Hearth shop, and the load factor of the units being considered, especially in such times when a furnace today is operating two or three days a week compared to six and seven days a week under full operation conditions.

"These, however, we have not yet considered, but should be discussed when comparing plants.

"We have given you a somewhat lengthy discussion of how this fuel audit report has grown and we had but one idea in so doing. That is we wish to show you that we are intensely interested in such work and I am quite sure, that our Management would be pleased to enter into, and have a representative from the Combustion Department work with, such a committee in an effort to establish a standard method of comparing fuel efficiency records in the various steel plants of the country.

"Personally we like the idea immensely and will be very glad to do everything in our power to help along such a cause."

▲

2. "I think the long wrangle that such a drafting would cause in and to the Committee and outside of it, wouldn't be justified by the good that a prescribed and agreed-on formula might bring to the steel industry.

"Let us assume that an amiable adjustment has been accomplished and all agree to follow the formula, there still would remain question on the apparatus for determining the basic data to be used in such a formula, and which ought to be obtained in practice by direct and approved methods of measurement. I know, for instance, that a different type of measuring equipment is in use in different plants and under highly variable conditions of operation. It would probably be necessary to change such equipment in many plants, yet the value of such changes might not be evident in view of the conditions peculiar to the plant. For example, the equipment might be obsolete and future changes are contemplated, hence, immediate changes in measuring apparatus would not be considered.

"I think I had better cut the subject short. It could be prolonged indefinitely, but I fear it would lead us to no definite port. In view of the many fine standards already available in the proceedings of the various engineering societies, I question the value of the enormous amount of mental energy that would be required by the formulation of standards for such equipment as heating furnaces in the steel industry. I would therefore recommend for consideration to the three members mentioned in your

letter thorough consideration of all facts and factors in the case and would admonish them 'to make haste slowly' in such a matter."

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3. "Following is a brief outline of the thoughts I have had to date on the subject:

"1. We would be very careful not to duplicate work already done or being done by other Associations or Research bodies, rather if any similar work is under way, to co-operate with them.

"2. There is no question in my mind as to the usefulness of any work to be done on the subjects by parties not interested in the sale of one kind of equipment.

"3. Are there enough active members not already sufficiently busy in the other Divisions of the Association to make up another new Division? In other words, the important work being done by other Divisions at present should not be lessened.

"4. I am strong believer in the theory that there can be no standing still in any project, in this world, you either have to progress forward, or slip back, however slowly. Therefore I admire the policy you have of taking up new things, for consideration at least, for in this way must the Association progress and make itself of increasing value to the Iron and Steel Industry.

"Please feel at liberty to call on me for any help I may be able to give at any future time."

▲

4. "Your letter of October 15 indicates that there is an inclination to 'standardize' the 'Methods of Comparing Fuel Efficiency Records.'

"The effort may well engage the attention of combustion engineers. But there are two things which should receive prior consideration before such standardization is undertaken, viz.

"The questionnaire which may be sent out to many steel plants will receive replies that represent the contaminating influence of many accounting practices that do violence to both physical and engineering concepts and yet have to be tolerated by the combustion engineer. These erroneous measurements or rather units of measurement, are enforced by the authorized accountants with the result that comparison of the practice in different plants are unsatisfactory if not impossible simply because there is not a statement of the facts. I hope that any committee of this Association which undertakes this work will ignore the 'average practice' that may appear from the proposed questionnaire as a precedent which is to be recognized and for once insist upon methods that have the inherent characteristic of rationality.

"The word 'efficiency' and the applications of the ideas which it represents will receive prominence in much of the future work of this Association and chiefly because the work of the engineer has given it meaning not within the comprehension of Webster. If all forms of heat application were expressed in terms of units of energy the term 'efficiency of a furnace' would be quite as intelligible as the statement of the 'efficiency of a motor.' The complexity of units employed in measuring the effect of heat applications will require of the committee of this Association a clear definition of 'efficiency' before applications in detailed technical matters are contemplated. With this in view I would offer the following text for amendment, correction or amplification as an examination of physical laws and the facts may require, viz.

"Efficiency is a ratio of two quantities capable of measurement by the same physical units or standards.

"The numerator of this ratio is the total quantity of energy or heat that is usefully applied.

"The denominator of this fraction is the total available heat or energy referred to some physically attainable base point or plane of reference.

"The ventilation of these concepts will require clear thinking, definite knowledge and arbitrary defense of facts instead of precedent."

▲

5. "In reply to your letter of October 12 with regard to formulating a standard method for determining fuel efficiency, I feel that this is a worthy subject for attention. As your letter states, it is one of difficulty and complication, and in my opinion should only be undertaken if you are able to secure a Chairman for a committee who is sufficiently qualified and also has the interest and time to bring the matter to a successful conclusion. I do not think that desultory treatment of such a subject will be of any benefit or of any credit to the Society. It would seem, therefore, that the action of the Society should be based on the availability of correct personnel. Careful consideration of the subject by such a committee is, unquestionably, very well worth while."

▲

6. "A standardization such as proposed would be very satisfactory, particularly if the low heating value of fuels, net tons and a good steam unit could be put across.

"It is extremely difficult to get most companies to change thier standard units, but that is no reason why engineers should not think in terms of logical units. Methods of comparison of results and costs under varying and fluctuating loads would be of great value if too much labor were not involved in the study."

▲

7. "With regard to your inquiry about a standard method of comparing fuel efficiency records, I would say that several years ago I advocated that steps should be taken to standardize fuel values and methods of heat value calculations and that I still believe that this question deserves serious consideration."

▲

8. "In response to your questions in the letter of September 29, I feel that all combustion problems should be computed along standard lines, that is: identical formulas and forms should be used, when presenting combustion problems.

"In the face of the fact that economy of modern devices and methods is not only dependent upon normal operation, but also upon maximum and curtailed operation, it should be pointed out in combustion analysis how much the running and fixed charges amount to at various operations.

"I am afraid that prevailing competition does not permit to tell the How and Why by engineers connected with various concerns.

"The above suggestions are a little more definite

than the ones proposed by three members (letter October 14) although said members have given at least a hint for the final goal."

▲

9. "It is the opinion of the writer that the suggestion for establishing a 'Standard Method of Comparing Fuel Efficiency Records' is very good and should be adopted as part of the Combustion Engineering Division's program."

▲

10. "Replying to your letter of October 16, 1931, wherein you seek an opinion for adapting a standard for comparing fuel efficiency records, the writer is of the belief that if a standard was set up, it would be a wonderful help to all concerned."

▲

11. "Replying to your letter of October 14 regarding Standard Method of Comparing Fuel Efficiency Records, I believe that this suggestion is an excellent one, so that Engineers may have a true comparison of their actual performance. This whole question is very involved and may lead to endless discussion, but if properly handled, should result in considerable good to the Industry. I would suggest that some provision be made to determine the kind of product for instance in the Open Hearth practice, fuel performance will be different with different percentages of cold charge and also with different carbon content in the finished steel."

▲

12. "Replying to your letter of October 12, the suggestion you embodied in your letter is simply an idea which we have had in our mind for sometime which we explained in our paper delivered at Cleveland in June this year. However, I am glad to see that someone else is anxious to give the movement a trial and I feel sure you can count on our co-operation one hundred per cent."

▲

13. "I think the letter you sent me on the subject of meeting to standardize the methods of computing and comparing fuel records is one that should be of great interest to the whole industry.

"During the reading of a paper in Youngstown some time ago, and also at Cleveland, I believe I commented on this phase of the comparative data. Each plant takes quite some liberty in arriving at the final results and while they are correct, for the Plant's purpose, they are often of little value in comparing Plants of different Companies, without a large amount of interpolation.

"I will be very glad to lend my help to any movement in straightening this out."

▲

14. "I have looked over this letter fully and have done a lot of thinking about this subject, and have always come back to the conclusion that whoever suggested the submission of a standard method of comparing fuel efficiency records for open hearth furnaces, heating furnaces, boilers, etc., is on the right track, for I know of no other method by which it would be possible to get a direct comparison between the different plants. I feel sure that if this method is adopted that it will not be very long before we shall have a lot of records which will be of great value to the Industry.

"For your information, I might state that while visiting a steel plant about two months ago I found that they were having a conference of all the auditors of the different steel companies, with the idea in view of adopting a standard cost sheet so that when they compared costs everybody would be on the same basis and know exactly where they stand, and this is exactly the same answer that you are striving for in connection with fuel efficiencies."

▲

15. "In reply to your letter of October 16 relative to standard methods of comparing fuel efficiency, we believe that this step would be of great benefit if some standard form could be devised. The question has been brought up a great many times and nothing has ever been done to correlate the data from different plants.

"Of course, the big objection is the fact that the accounting departments set certain of the figures and the engineers in the individual plants have to cooperate with the accounting department in order that the figures will be available for cost sheet purposes. Some work has been done along these lines, particularly in the boiler field but practically nothing has been done as far as industrial furnace work is concerned.

"We believe that the best method of attack would be to start with what is common practice in the boiler plant and enlarge and develop such findings into the industrial furnace field. The questionnaire method of obtaining the factors, values and methods now in use at the individual plants would have to be obtained before any correlating of the work could be attempted."

▲

16. "In reply to your letter regarding Standard Method of Comparing Fuel Efficiency Records. In my opinion the necessity for such a standard is without question. Its importance will increase as business moves out of the present depression and competition becomes increasingly severe. While considerable work has been done along this line in the field of steam generation, practically nothing has been done regarding industrial heating furnaces. I realize that this will be quite a task and that considerable time and effort will be required for its accomplishment. I believe, however, that such a movement sponsored by the Association would be well worth while. It would also have the added benefit of creating a definite interest in the efficiencies of all heating operations.

"I will be pleased to co-operate to the fullest extent in the matter."

▲

17. "Such work would be of major value. I find many of our own plants are not comparable. When comparisons are made the average cost sheet contains more mis-information than it does reliable data."

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18. "I believe that the suggestions outlined in your letter of October 13 as made by several members of our organization are well worth considering; and if I may offer my own suggestion I would rec-

ommend, that in establishing standards for the ready comparison of performance data the well developed practice of the German Heat Economy Bureau be also taken into consideration as permitting check-up on performances of equipment, not only in this country but in other countries also. This semi-official body of Fuel Engineers, which functions in Germany somewhat on the order of our Bureau of Standards or Bureau of Mines, except that it concentrates on fuel economy exclusively, has compiled valuable references which may well serve as a guide for formulating standards for our own organization."

▲

19. "In reference to the suggested topics for combustion problems for the Iron and Steel Industry today, I believe one of the major things we should stress is standardization. There are only a few of us who are using the same methods of computing various efficiencies, etc., and I believe it would be well worth while if a large part of our effort this year was used in determining a standard method of reporting fuel heat balances, boiler operation, etc.

"It seems to me that the better way to handle this would be to send out very carefully worked out questionnaires and secure from various engineers the exact methods they are using and then have a round table discussion and determine the correct units, method of arriving at these units, etc. It will be an immense job to get all of the details worked out. It will be essential to have our standard thoroughly explained and then sample calculations made, going into the details of each and every phase of these standards in order to have all parties understand and use the same methods. This may work considerable hardship on some plants, who are using different methods on cost sheets, as some plants will use 'Boiler Horse Power Month,' and others use '1000's pounds of steam,' etc., when computing commodities of similar nature.

"I am not in favor of the symposium method until the subject is fairly well thrashed out. A small representative group can work out the major projects in the earlier stages of the program before calling in the full committee.

"There are numerous phases of combustion which might be handled such as recent developments in individual units, modern boiler plant design and operation, etc., but I believe we should confine ourselves to one or two major things and do them well rather than try to touch a great many fields."

▲

20. "I refer to your letter of October 15 on the above subject. The determination and compiling of data showing efficiencies of steam generating equipment and unit costs of delivered steam in such a way as to permit of ready and accurate comparisons should be of definite value to Combustion Engineers in particular, and to the Steel Industry in general.

"As stated in the suggestion quoted in your letter, the writer concurs in the thought that it would be very difficult—if not impossible—to have all plants accept a common method for calculating efficiencies and steam costs, but it is quite possible that a great many of the plants could, with the data already at hand, and with very little added effort, secure an additional set of results in accordance with a definite method of procedure as submitted by the Committee. While the individual plants, for their own purposes, would consider this set of results as supplementary, the value of discussions and meetings on the subject of Combustion from the standpoint of the Association, should be greatly increased, and I feel that it would be worth while to make investigation to determine what could be accomplished along this line."

▲

21. "Your recent letter conveying suggestions of several members toward standardizing records of fuel efficiency particularly in metallurgical furnaces has been noted with much interest.

"However, it is doubtful whether application of satisfactory metering equipment to metallurgical furnaces is wide spread enough at this time to permit standardization of records.

"We, who are familiar with the N.E.L.A. Prime Movers Committee, have the utmost respect for their work. Through their yearly committee reports covering different phases of power generation, they are approaching standardization of not only records but equipment as well and this in a field which otherwise would permit diversification of design which would increase the difficulties of equipment manufacturers and ultimately prove economical to the users.

"This Prime Movers Committee reports, each covering only one phase of power generation, are most carefully edited and include a statement of summaries of experience and suggestions for improvement by the committee, statements of experience by member companies and statements covering equipment and application by manufacturers. A small charge is made for these reports and I believe the publication is self supporting.

"If the Association has a small amount of money available to start a publication of similar nature, I believe enough members among the steel companies and instrument manufacturers could be interested to prepare a very interesting report. It seems to me that since the Open Hearth has been the center of a very lively interest in combustion lately, it would serve as a most satisfactory subject for the experiment. I believe that through a publication of this nature, the experience of the different companies could be well enough coordinated so that within several years time, a satisfactory method of standardizing fuel efficiency reports could be reached. However, I question the possibility of arriving at a satisfactory method of standardization without this preliminary coordination of experience between the interested parties. We will be glad to co-operate in any way to further this or any other satisfactory plan."

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22. "We should have answered the first letter some time ago but were in the process of thinking it over and had not developed a suggestion which we thought worth while to pass on. However, the suggestion contained in your letter of October 16 as submitted to you by three of your active members of the Combustion Engineering Division seems very well worth while.

"We have discovered much the same difficulty in reading reports of efficiencies. We have had to determine the various factors and standards used in

these various reports in order to reduce them to a common basis for comparison.

"I think the standardization of such reports would be not only very interesting but extremely useful. If we should happen to come across any ideas later for useful and interesting discussion we will most certainly pass them on to you."

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23. "We agree that the suggestion in your letter of October 12 has merit and are authorized by our Management to co-operate with such a program."

▲

24. "I have been thinking over your letter of September 29 and would suggest something along the following lines insofar as combustion problems in the Iron and Steel Industry are concerned:

"First, an appraisal of the different fuels available to determine the value of B.T.U. in the various forms in which it may be used.

"Second, a classification of the different uses to which fuel is put and a determination of the relative values of the different fuels for each particular use.

"It may be that the subject matter I have in mind for these two headings could be arranged in different order, but that could best be determined after some outline had been made of the material available.

"In some cases it is customary to rate fuels on a B.T.U. basis which evidently does not represent their true value. For instance, suppose both coal and gas are available for any operation involving the application of heat. If both were available at the same price per B.T.U. considerable saving could be effected by using the gas. In the first place the gas burning equipment would cost substantially less than the coal burning equipment; the use of gas would eliminate the handling expense which would be charged aaginst the coal burning; there would be no ashes to dispose of; and if a substantial amount of equipment were concentrated in one building, as for instance, in a large boiler plant, the labor cost of firing would be substantially less.

"When it comes to the consideration of a large number of comparatively small users of fuel scattered over one large steel plant, the value of a fluid fuel as compared with solid fuel becomes greater because of the great saving that can be made in the distribution of a fluid fuel as compared to the cost of distributing solid fuel, providing for some storage at the different points of use, and then disposing of the ashes.

"It is quite likely that the two headings listed above could be more advantageously arranged by a consideration of the problems according to the different classes of fuel burning equipment. For instance, one might first take the generation of steam and consider all the factors entering into the final cost of steam that would effect the value of the different forms of fuel. If solid fuel is to be burned, there must be considered the design of furnace suitable for the particular fuel, the cost of fuel burning equipment, the cost of ash disposal equipment, the labor cost, and the efficiency that can be secured. When a gaseous or liquid fuel is burned, there are differences in plant design, fuel burning equipment, etc., all of which would result in giving B.T.U. in the form of gas a somewhat higher value than the B.T.U. in the form of coal.

"When it comes to the open hearth, consideration should be given to tar, oil, coke oven gas, and mixed gas, and an attempt made to properly evaluate the different factors that would effect the B.T.U. value of the different fuels.

"There remains a large variety of re-heating and annealing furnaces, some of which are coal fired, some oil fired, while others use various gases.

"I realize that a lot of work would be involved in working out something of this kind and it could only be done by engineers experienced in handling the fuel problems in steel mills. I believe, however, that a lot of information of real value to engineers could be gotten together by a study of this kind. For instance, in any steel mill there are certain fuels available in more or less definite quantities and there is a problem to be solved in determining where the different fuels available can be used most advantageously. Naturally, the different fuels should be used up to the limit of their availability for those operations where a particular one was most valuable, and when all of that fuel available has been allotted to different uses, then the next fuel should be fully utilized, finally, making up the balance of the fuel requirement with the fuel of least value. It is recognized, of course, that the actual values would differ in different localities, but I believe a great deal of valuable information would be made available merely by a well worked out scheme approaching an analysis of this kind, so that other engineers could take the same information and by following out the method established, and using their own particular figures for fuel cost, arrive at a set of figures that would represent the comparative values of the different fuels for each fuel-consuming operation he had considered."

▲

25. "After having given this suggestion careful consideration, we believe that the subject would be an excellent one for discussion.

"However, in embarking upon a program involving extensive discussions of this subject, we believe it to be quite important that the authors of papers or committee reports be instructed to express their values in terms of B.T.U.'s or other positive heat units rather than in terms of pounds of coal or pounds of steam, which have no definite heat equivalent. We can foresee the possibility of wasting a considerable amount of time and effort in attempting to carry out this problem if each author is left free to express his results in units which cannot be definitely interpreted by all concerned."

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26. "It would be very much worth while if some sort of code for determining thermal efficiencies of heating furnaces might be worked out. This is a complicated problem and will require a good deal of thought and study, but I think if it can be well started this year, the committee will be doing something for the advancement of the art. Both the National Electric Light Association and the A. S. M. E. have done similar work in connection with steam boiler operation and I think that it has proven to be very valuable."

27. "I read your letter of October 13, on the subject of standard methods of comparing fuel and efficiency records, and wish to say that the suggestion offered by one of the members is a very good one, and I am fully in accord with the Association forming a committee composed of steel plant engineers with the idea of having a standard method of reporting fuel and steam efficiency data prepared, such as being done by other associations.

"I think that this would be quite a help to operating engineers in the steel plants."

▲

28. "We endorse the suggestion of your members for standardized fuel efficiency records.

"May we add to such program a corollary which is essential: that such tests embrace a standardized measure of capacity. Furnaces, particularly, may show good fuel efficiency rates but be deficient in flexibility, maintenance costs, and in steel heating or melting capacity. This factor is as essential as exceptional fuel rates.

"The program should also cover high efficiency hot blast stoves, both as to gas consumption per blast unit (or efficiency) and capacity (or heat reserve duty). With the advent of such stoves there is a considerable lack of sound comparable basis for specification of performance in sales proposals, as well as in statement of actual performance."

▲

29. "This strikes me as a very valuable suggestion. We have run into this difficulty in getting information from the different steel mills for making studies of their requirements, and it has been necessary to spend considerable time in interpreting the log sheet and records of the different companies as nearly all of them use different methods in keeping these records.

"It is, of course, going to be difficult to get them all to agree on a single system, but it was also difficult to get the power plants in the early days to have their meters calibrated in pounds of steam instead of boiler horsepower, and I think most of them today have come to the conclusion that pounds of steam is the right one to use, and where they still cling to the boiler horsepower they also have thousand pounds of steam on the same meter, and eventually will discard the boiler horsepower."

A Review of Electrical Development in the Iron and Steel Industry

By W. B. SHIRK

Steel Mill Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

During the past three years there has been a number of remarkable developments in the Iron and Steel Industry. New lines of thought resulting in new projects and new processes have been commercialized within a short space of time. By adopting the use of electrical apparatus from the start, new developments have appeared with such frequency that a detailed review of only a few would occupy many pages.

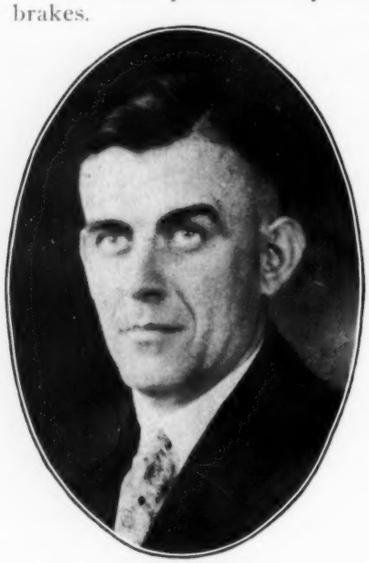
The increasing use of electrical apparatus for controlling more accurately and more efficiently the detailed operations associated with blast furnace operation has had a marked effect in encouraging blast furnace engineers to build larger and more efficient furnaces in order to secure a more profitable utilization of blast furnace by-products. No review of developments associated with blast furnace operations can neglect to mention the trend toward larger furnaces. It is interesting to note that there are now several furnaces in the United States which are producing more than a thousand tons daily. Increasing the productive capacity has had a far reaching effect upon construction programs and upon the cost of producing pig iron. The enlargement of existing blast furnace plants has been so generally successful and satisfactory from the standpoint of cost reduction that the building of new units has been brought to a standstill.

As the producing capacity of the blast furnace is increased, it is only natural that the capacity of the drives associated with the furnace operations must be increased in order to have a balanced working unit. In order to obtain reduced maintenance costs and at the same time increase the capacity of the charging equipment, electric motors and variable voltage control have been applied to several skip hoists within the past few years. By using variable voltage control the operation of the skip hoist can be made semi-automatic thereby deereasing maintenance cost when compared to the steam driven or constant voltage skip hoists.

Increasing use of electrical apparatus associated with blast furnace operation has progressed to such an extent that at the present time economical auto-

matic control of the products of combustion entering the stacks and stoves can be obtained by the use of suitable motors and control. The flexibility of electrical motors and control has caused blast furnace designers to study the possibilities of an automatic furnace and a one man stock yard.

To further expand the use of electrical equipment associated with blast furnace operation, a large steel plant in the Pittsburgh District has recently placed in operation a 15-ton ore bridge which contains many new and novel features in order to reduce maintenance cost, increase reliability of operation and also increase the safety of the operator. The ore bridge is of the man trolley type using electro-pneumatic control and pneumatically released and spring set brakes.



W. B. SHIRK

Years past when the trends of steel production for open hearth furnaces were being suggested many maintained the impracticability of such proceedings or that it would be impossible to attain quality suitable for severe specifications. This practice ended suddenly with the advent of the World War. All precedents and customs were immediately set aside because mass production had to be obtained without delay. Almost automatically furnace capacities were increased 50% or more without sacrificing quality. Since 1914, tons per furnace hour have increased from 7 to 9 tons per furnace hour for a furnace rated approximately 100 tons capacity. There are, however, many larger furnaces in successful operation producing as much as 17 tons per furnace hour.

The various operations associated with open hearth operation are practically all electrically operated. However, it might well be mentioned that with the demand for still greater output more accurate and more reliable control will be required in order to obtain better and uniform quality. Automatic furnace control is gaining ground every day and undoubtedly will be universally used in a very short time.

The continual improvement in the means for handling and transporting material between the various producing units in a steel plant has been one of the contributing causes for the reduction in cost of steel products. However, all of the links in the chain of transportation from the receiving of ore to the shipment of the finished product have not been developed as aggressively as other related operations. The first links to receive the attention were those that fell most directly under the production managers' control and in places where a saving was obvious. Car dumpers, ore bridges, cranes, tables, furnace chargers, and even the location of the mill building and the mill were given much consideration.

FIG. 1—70-ton, 300 HP. Westinghouse Oil Electric Locomotive for Industrial Switching Service.

Most of the steel plants today still have a weak link which they allow to exist and do their best to forget. This link is the steam locomotive in the yard.

The ability of the oil-electric locomotive to save money in maintenance lies in the ability of the ordinary workman who can fix an ordinary automobile, to replace worn or broken parts quickly and cheaply. There are no boilers to wash or ashes to handle.

The improvement caused by the uniform torque of the electric motor over that of the side rod on the steam locomotive makes the use of higher adhesion feasible, or lighter locomotives for the same work. With smaller torque variations applied to the wheel rims there is less tendency to slip so the average torque can be raised. The weight reduction

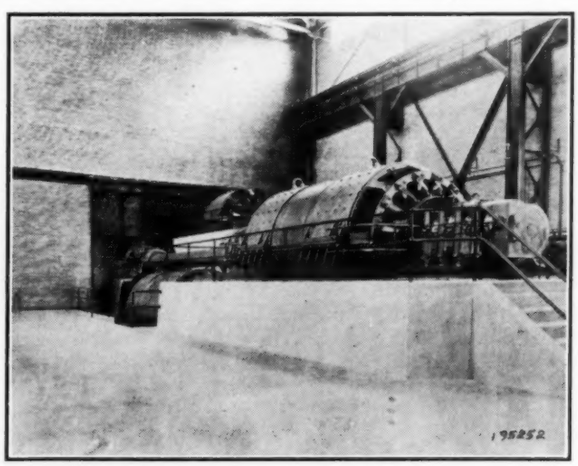


FIG. 2—12,500 HP. 3 Motor Drive for 44" Universal Slabbing Mill.

alone save the equivalent of the work done in pulling a loaded car around on every move all day long. This means less fuel burned on the oil-electric locomotive. The cost of water is virtually all saved by the use of the oil-electric locomotive as it uses water for cooling purposes only.

As in other branches of industry, it is quite probable that a machine which offers as many possibilities for operation savings will cost more initially. Usually the cost is double that of a corresponding steam locomotive.

A typical comparison of operating cost between oil-electric and steam locomotive is as follows:

Cost Per Hour, 300 HP. 60 Ton Electric vs. Steam: Switchers

	Oil-Electric	Steam
Crew Expense	$ .92	$1.62
Fuel	.25	1.07
Supplies and Lubrication	.09	.06
Water		.05
Engineering Expense	.13	.70
Repairs	.76	1.30
TOTAL	$2.15	$4.80
Interest and Investment	.50	.20
Depreciation	.28	.10
GRAND TOTAL	$2.93	$5.10

Saving per hour using oil-electric over steam = $2.17
Saving per year using 3,600 working hours per year = $7,812.

In order to maintain high tonnage output on reversing mills, it is necessary that the ingot buggy be capable of delivering ingots to the mill approach table at a rate which corresponds to the maximum producing capacity of the mill. There is installed in the Pittsburgh District a 20-ton electric locomotive used for hauling the ingot buggy between soaking pits and a 44" reversing blooming mill. The ingot buggy is arranged with a mechanical tilting device, the crank arm of which extending on either side of the ingot tilting car engages with ramps adjacent to the blooming mill table and thus the ingot is discharged automatically on the blooming mill approach table.

The locomotive and ingot buggy operate over a 42" gauge track which is practically straight and level for the entire distance of the travel which averages 325 feet one way or 650 feet average round trip.

The maximum operating conditions require the locomotive to place approximately 75 four-ton ingots every hour on the blooming mill table. This requires a round trip to be made in 48 seconds, 8 seconds of which are allowed for loading the hot ingot onto the ingot buggy and unloading the ingot on the approach table. The actual time the train is in motion from the soaking pit and return is 40 seconds or approximately 20 seconds for the movement with the ingot and 20 seconds returning with the empty car. During the operation the train attains a speed of 20 miles per hour.

The locomotive is of the well known Baldwin-Westinghouse Barsteel frame type equipped with 44" diameter steel tired wheels, two 150 HP. commutating pole type traction motors with single reduction helical gearing axle mounted, electro-pneumatic control for parallel operation of the motors, straight air-brake, third rail shoe type of current collector, air operated clapper type bell, air whistle, a motor driven fan for supplying forced ventilation to the traction motors, and a heavily reinforced steel cab at the controller end of the locomotive.

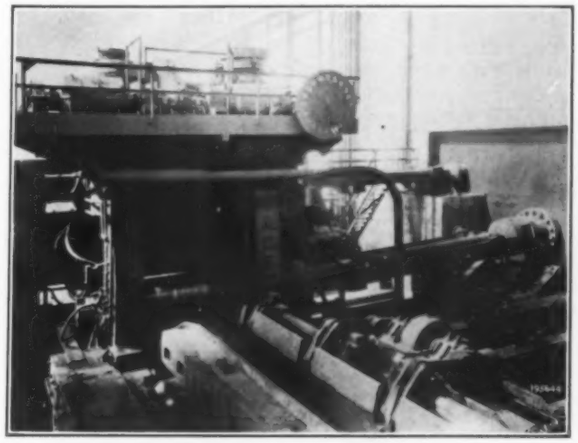


FIG. 3—44" Universal Slabbing Mill Installed in the Chicago District.

Within the past three years a great deal has been written of four-high mills that it is rather difficult at this time to present any new material. However, we might state that the four-high mill has met with unequal success in that it has performed beyond all expectations.

To further improve rolling mill performance our company introduced and placed into successful operation within the past two years, two reversing "twin-motor" drives.

Both installations are located in the Chicago District. One 10,000 HP. "twin-motor" drives a 54" reversing blooming mill and the other unit which is a 10,000 HP. "twin-motor" drives the main horizontal rolls of a 44" reversing universal slabbing mill. The 54" mill equipment has been in service since December, 1930, and the 44" mill equipment since April, 1931. Both drives were started and operated with no more difficulty than experienced with any reversing mill equipment.

Due to the absence of a pinion stand each horizontal roll of a "twin-motor" drive is driven by an individual motor. Elimination of the pinions and splitting the drive into two parts reduces the total inertia of the drive which results in a greater torque made available for both acceleration and rolling purposes. Eliminating the rigid mechanical connection due to the pinions also introduces additional flexibility in the drive which permits higher entering speeds for a given size of ingot over that obtained with the conventional type of drive. Higher entering speeds results in a greater tonnage output. The individual drive for each roll permits the use of rolls of unequal diameter which results in a decrease in spare roll investment. Eliminating the pinion housing increases the performance of the drive due to the losses in the pinion.

Five successful installations of "twin-motor" drives have been made by our company within the past four years on reversing mills, tube mills, and cold mills.

In four-high mills any inequality in roll diameter with the conventional type of drive will cause internal torques of such a magnitude when rolling thin material that roll breakage will result. The use of a "twin-motor" drive eliminates the necessity of matching rolls and therefore reduces roll expense and roll investment. In addition the use of a "twin-motor" drive permits heavier drafting due to the fact that the absence of pinions eliminates pinion marks on the product caused by overdrafting in the conventional type of drive.

Due to the advantages and performance of the "twin-motor" drive for any class of mill the conventional type of drive can hardly be economically justified when considering the demands of the present day purchaser of steel products as regards quality and finish.

During the past year our company placed on the market a new line of direct current mill type

FIG. 4—Photo Electric Tube and Amplifier Unit. Amplifier Unit Shown at Left and Photo Tube at Right.

auxiliary motors and heavy duty steel mill magnetic controllers.

The new line of motors meets the standardized dimensions of the Association of Iron & Steel Electrical Engineers. The design incorporates several improvements in the construction of field coils to prevent movement and chafing. Rigid clamping of the bearing housing prevents movement of the bearing housing in the frame. The only soldered connection in the electrical circuit is between the commutator and the armature coil, all other connections are brazed. Removable frame hinges permits close mounting clearance. The accessibility of holding down bolts permits the use of standard wrenches when the mounting side clearance is a minimum.

The new type SM steel mill magnetic controllers parallel the new line of mill type motors. The contactors have unusually high speed operation and specially designed arc boxes and arcing contacts which result in high rupturing capacity. Fast opening of the contacts assist in rapid extinction of the arc which results in long life of the contact tips, arc boxes and adjacent parts.

The new TI thermal instantaneous overload relay included on the new controllers makes use of the characteristics of invar metal changing its magnetic properties at certain definite temperatures so that thermal protection is afforded at normal motor rating with the added feature of instantaneous tripping at about 400% load.

Due to the improved features incorporated in the new mill type motor and controllers, low maintenance cost in mill operation will naturally result.

The past year has seen a rapid increase in the number, diversity and ingenuity of applications of light sensitive devices. Electrical men and production superintendents will soon realize the usefulness of this remarkable new tool—the "Electric Eye". Daily, new uses are found for the photocell and the number of these applications already so expanded that the "Electric Eye" bids fair to penetrate every phase of the steel making process.

Light sensitive devices are now controlling and operating successfully soaking pit covers, repeaters, shears, and various mill table operations. The characteristic of the photo-electric cell gives the plant electrical engineer a new tool in which there are further possibilities to improve operation and consequently reduce cost.

The past three years has witnessed the installation of a large number of individual roll table drives. Due to the increase in performance and the reduction in maintenance expense by the elimination of lay-shafts and bevel gears, the future indicates the general adoption of individual roll table drives for the majority of operations.

FIG. 5—Fourteen Rectangular Bell Type Electric Furnaces

A new departure in cold rolling strip steel is the use of the electric furnace. The furnace requirements of the steel maker and steel user during the past year has been extended over a wide field. The general search has been for furnaces that would give greater production in the same space, less cost per lb. of steel treated and at the same time, fit in closely with straight line production. Besides these requirements have been the further development of special process furnaces such as for nitriding and bright annealing.

The process of bright annealing low carbon strip steel in coils has made considerable stride in the past year. The installation of 24 cylindrical bell type furnaces in one installation in the plant of a large manufacturer of strip steel bears out the prediction that still better quality is to be required. Other small installations are being made rapidly.

The furnaces as furnished include bases and light weight alloy hoods. Hoist and base moving equip-

ment is usually provided when desired. These furnaces have reduced the total annealing time of coil strip steel from four days to two days and in some cases have reduced annealing costs as much as 50%. The standard bell type furnace used at the present time is usually rated at 90 KW. 220 volts, 3 phase. The heating elements are on the wall and in a central heating unit which extends downward thru the coil center to the bottom of the charge. The temperature is controlled automatically by means of pyrometers and control panels.

Summarizing we would say that with the electric annealing furnace a better quality of product is obtained at a lower fuel cost. The increased cost of

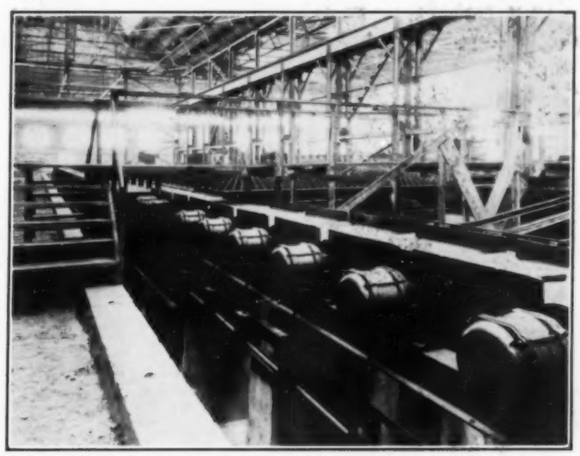


FIG. 6—Individual Roll Drives. Motor Rotor Pressed on Shaft Extension.

electricity for heating has been more than overcome by the more efficient application of heat, due to the better furnace insulation and less weight of auxiliary equipment to be heated, by speeding up production and by lowering the temperature gradient between the heat source and the point of use which gives longer life to the equipment. The use of the electric furnace with more even annealing attained by more accurate furnace control has resulted in fewer rejections due to the improper annealing and to other causes, less reannealing, reduction in labor cost and more comfortable working conditions.

The generation of power in steel plants has been in many cases largely a haphazard growth. Originally relatively small generating stations were installed to supply power for mills and as the demands increased, additions were made from time to time with the result that as a whole they were relatively uneconomical. In a modern plant with blast furnaces the generation of power is largely tied up with the utilization of the surplus blast furnace gas. As the plants developed and main drives added the question of power supply has become relatively more important. In general as the generation of power is an auxiliary operation and a power plant is not classified as a direct producing unit, it has not received adequate engineering attention and has been subordinated to the more important work connected with other producing units. The present day necessity of exploring every means to reduce operating cost has directed attention to such auxiliary operations and the provision for economic generation of power has been one of the factors which has enabled costs to be reduced.

Demands for higher standards of service and greater operation economies brought about developments in generator and prime mover characteristics suitable for parallel operation between units. The advantage of operating several stations in parallel were soon realized. This of course presented new problems which were solved after extensive study by providing suitable tie-line capacity and voltage regulating equipment at the various generating stations.

Interconnection between systems located in adjacent plants have been made in order to provide a higher degree of service. Now that mutual benefits derived from interconnection in the interest of continuity of service, better utilization of fuel resources and reduction in space capacity has been generally recognized, extensive permanent interconnection between the large industrial users and public utilities will result in still further economies.

By adopting modern illuminating systems, the steel producer, has been assured of quality production. Modern illuminating systems have also given the operators additional protection when working in dangerous locations thereby reducing lost time accidents to a minimum.

In order to provide the highest grade of illumination at low maintenance costs our company proposes to equip their Chromilite High Mounting Units with heat-resisting clear glass lenses, gasketed to the flange of the reflector in order to make the unit practically vapor proof. Such an arrangement will provide additional protection to the reflecting surfaces thereby increasing the life of the unit and also maintain the desired intensity of illumination over a greater length of time. By adopting a protecting lens and therefore increasing the accessibility of the surface to be cleaned lower maintenance cost will result. The cost for cleaning and also the time the unit is out of service can be reduced by providing suitable automatic cutout hangers.

Altho the writer has prepared in a sketchy way the developments and trends that are likely to take place in the Steel Industry we are hoping that the facts contained herein will be an inspiration to those engaged in the operation and maintenance of steel mill equipment so that further benefits may be accomplished by the utilization of improved equipment.

A. I. & S. E. E. COMBUSTION ENGINEERING DIVISION

ALL DAY TECHNICAL SESSION

THURSDAY, MARCH 24, 1932

OHIO HOTEL YOUNGSTOWN, O.

SYMPOSIUM

On

Mechanical, Combustion and Electrical Developments in the Iron and Steel Industry

James A. Farrell, in his office at 71 Broadway, New York, opening the 25th A. I. & S. E. E. Convention and Exposition held in Pittsburgh, June 17-21, 1929.

James A. Farrell to Retire in April

James A. Farrell, President and Chief Executive Officer of the United States Steel Corporation, announced recently that he would retire on April 18 at the time of the annual meeting.

Mr. Farrell has been President of the Corporation for more than 21 years, his appointment as Chief Executive did not come until December, 1927. This title had been held by the late Judge Gary in addition to the Chairmanship of the Board of Directors. Mr. Farrell will remain as a member of the Board of Directors.

Mr. Farrell is keenly interested in engineering developments. It was on June 17, 1929, that he opened the Twenty-fifth Convention and Exposition of the Association of Iron and Steel Electrical Engineers by an engineering feat. Seated in his office at 71 Broadway, New York, his voice was carried on telephone wires to a Pittsburgh broadcasting station and then broadcasted. The broadcast was picked up on a regular radio receiver and it was then for the first time that electricity obeyed the verbal commands of the human voice sent by radio.

STEEL RESEARCH PROMOTES SAFETY

F. R. Hensel and C. W. MacGregor, Research Engineers, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Stronger, safer, higher skyscrapers can be built, now that engineers have learned exactly what happens inside steel beams under the weight of a building. Similar improvement is possible in the construction of apartment buildings, hotels, bridges, elevators, mechanical machinery, in fact every place where steel has been put to the service of mankind.

Steel manufacturers and machine designers are now able to see the internal strains of certain kinds of steel in which the strain patterns were not visible until F. R. Hensel and C. W. MacGregor, research engineers of the Westinghouse Electric and Manufacturing Company, developed the method which they believe will produce greater safety in structural and other steel forms.

A steel member which has been stressed slightly beyond the limit of its elasticity will not return to its original shape after the load is removed. Such stressing of steel develops miniature flow lines on its outer surface. If this steel is then cut into sections, additional flow lines on the cross-sections will be exposed.

Ten years ago, A. Fry, a German physicist, discovered that by etching these flow lines with a solution containing hydrochloric acid, he brought the pattern of the strains in the metal into the sharp relief of a distinct black pattern, easily visible against the metallic white background of the unstrained portion.

Fry's discovery was of great importance to designers of steel structures and machinery. But its usefulness was limited because only steel with the proper nitrogen content could be successfully etched. Practically all such steel is manufactured by the Bessemer process and amounts to only about 12 per cent of all the steel produced.

Hensel and MacGregor, two Westinghouse engineers, set out to extend the etching process to open hearth steels, by far the most commonly used, and found that W. Koester, another German physicist, had traced the success of the etching process to the presence of nitrogen in the steel.

Experiments convinced Hensel and MacGregor that nitrogen was the controlling element, furthermore that it was beneficial only when it amounted to between .01 and .05 per cent of the steel's content. Tests of weld metal and Bessemer steel, whose nitrogen content is within these limits, verified these conclusions. The next problem was to find a successful method of etching steels having a still lower nitrogen content, such as open hearth steel.

Further investigation evolved a method of nitriding these open hearth steels so that, when they were etched, the flow lines and patterns of the strains within the steel would become visible. In this process, the test specimen is first stressed, then cut into sections to be nitrided and etched. This etching reveals all the flow lines on all surfaces of the specimen.

This stressing, cutting, nitriding and etching routine permits examination of the flow lines and strain patterns of steel members in practically every application. This includes the important application of shafts in torsion, and the examination of certain processed steels whose flow lines cannot be obtained by any other method.

Others had sought the solution by nitriding the material before stressing it, but this method had a very limited application and, in addition, revealed only the stress pattern on the surface of the test specimen, not that on its cross-section.

Summing up their work, Hensler and MacGregor laid down the requirements for successfully etching the strain patterns of steel members. The material must have a sharply defined yield point and must be stressed slightly beyond that yield point. It must have a nitrogen content between certain fixed limits; if it contains less than this amount of nitrogen, the deficiency must be made up by a nitriding process. Last of all, the material must be correctly etched.

DISCUSSION

By W. E. SYKES

Farrel-Birmingham Company, Inc., Buffalo, N. Y.

In your issue for November I have read an article entitled, "Points To Be Kept In Mind When Ordering Worm Gearing For Electric Overhead Traveling Cranes."

In the last paragraph the writer of the article states it is his opinion "that generally speaking, the use of worm gears in the United States on electric overhead traveling cranes will increase so rapidly in the next five years." I find it impossible to ascertain on what he bases this opinion.

The article seems to show that worm gears for cranes are exceedingly intricate. In paragraph A it is stated that the worms and gears must be of high accuracy type, the threads of the worms must be ground finished, and the worm wheel must be polished; provision must be made for accurate adjustment and great care exercised in insuring accurate adjustment of the tangencies of the pitch diameter of worms and worm wheels; thrust bearings must have sufficient capacity to resist loads. And in paragraph B it is stated that great care must be taken in the selection of a unit which has sufficient torque rating. In paragraph C it is stated that when the ratio of approximately 40 to 1 is exceeded the worm gear unit becomes self-locking and that trouble may arise from this. On the whole, therefore, it seems that a worm gear for a crane is a very intricate and delicate mechanism. For this reason I cannot understand why a worm gear is advocated for the purpose.

I have had a great many years of experience with gearing of all types but I have never yet been able to understand why anyone should use a worm gear for an overhead traveling crane. I do not know that it possesses a single advantage over a herringbone gear. A herringbone gear of high quality, as made by most of the gear specialists and by at least two crane builders, has every advantage over a worm gear. These advantages may be enumerated as follows:

(1) Silent operation.
(2) Maximum durability.
(3) High mechanical efficiency. (At least 98% for all ratios, all speeds and all loads.)
(4) Ratios up to 15:1 in a single reduction and 100:1 in double reductions, with efficiencies for double reduction not less than 96%, including bearing losses.
(5) Low first cost due to the fact that high grade non-ferrous materials are unnecessary, and hardening, grinding and polishing are superfluous and scarcely ever resorted to.
(6) A great capacity for overloads without any risk of injury.
(7) Larger load capacity for a given size than a worm gear.
(8) Can be operated with ordinary lubricants. (Even if an unsuitable lubricant is used no great damage is done.)
(9) Herringbone gears are not sensitive to dirt. They are reliable and will stand rough usage and a great amount of maltreatment.
(10) No thrust bearings are required, either plain bearings or anti-friction bearings are suitable. Anti-friction bearings of any type may be used, tapered, ball or cylindrical roller type.
(11) There is never any trouble with herringbone gears jamming from any cause.

I think all the above statements are reasonable and I also think they show that the herringbone gear has every advantage over a worm gear.

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TEN COMMANDMENTS FOR FOREMEN

The November, 1931, Safety Bulletin of The Norfolk and Western Railway Fuel Department contained the following. It has in it considerable food for thought.

1. Be fair. Have no favorites and no scapegoats. A foreman has to act as judge many times every day; therefore he must be just.
2. Make few promises and keep them. A foreman must be exact in this particular. Sometimes a foreman forgets that his job requires a high standard of truth and honor.
3. Don't waste anger—use it. Anger is valuable and should not be used carelessly. Keep your most forceful language for special occasions.
4. Always hear the other side. Never blame a worker until he has been given a chance to give his point of view.
5. Don't hold spite. When you have had to scold a worker, go to him and show his faults in a friendly way.
6. Never show disappointment. Never let yourself be beaten. A foreman must have perseverance and the "Never-say-die" spirit.
7. Notice good work as well as bad. Let the workers see you can appreciate as well as condemn.
8. Watch for special ability. Take a keen human interest in your workers. Put each one where he can do his best.
9. Take your full share of the blame. This is the most difficult of all. The foreman who can share both blame and praise with his workers has discovered the secret of managing them.
10. Prevent accidents. Educate or eliminate the careless man. The good foreman is known by his men.

ITEMS OF INTEREST

PERSONNEL CHANGES.

Henry F. Devens, identified with the steel industry for over a quarter of a century, has been elected president of the Oliver Iron and Steel Corporation, Pittsburgh. He has been with the Oliver corporation since 1923, and since January, 1930, has been vice president and general manager. As president, he succeeds B. D. Quarrie, who resigned nearly a year ago.

Charles McDonough has been appointed publicity manager of Combustion Engineering Corporation, New York, succeeding Carl Stripe, resigned.

W. R. Culbertson, formerly associated with the Chapman Engineering Company and the Chapman-Stein Company, Mt. Vernon, Ohio, in the producer division and later with the Surface Combustion Corporation, Toledo, Ohio, has resigned to accept a position with the furnace division of the Rust Engineering Company, Pittsburgh, effective as of January 15. He has had 14 years' experience in engineering work. In his new position Mr. Culbertson succeeds his brother, the late A. L. Culbertson. Mr. Culbertson is a member of the A. I. & S. E. E.

Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio, announce the appointment of Mr. W. J. Reeder as manager of its St. Louis Branch Office. This appointment fills the vacancy made by the untimely death of C. J. Prendergast, which resulted from injuries received in a building collapse at Paoli, Indiana a short time ago.

Mr. Reeder will be assisted by J. R. Buss, who has been located in the St. Louis district for the past four years. Their headquarters will be at 127 Waterman Building, 457 North Kingshighway.

Expansion of the research activities of the Midland Steel Products Company, Cleveland Ohio, and appointment of Howard F. Kulas, vice president, to head the experimental and research division and to devote full time to its work, are announced by E. J. Kulas, president.

H. C. Thomas has been appointed Assistant to General Works Manager of the Westinghouse Electric and Manufacturing Company. He is being advanced from the position of Director of Manufacturing Stocks, which appointment was received in September, 1929.

Una Welding, Inc., under the management of The Clark Controller Company, both of Cleveland, Ohio, have placed R. A. Kyle as welding representative for the New York territory. Mr. Kyle has opened an office at 51 East Forty-second street.

Clarence E. Searle, General Representative of the Allis-Chalmers Manufacturing Company, has resigned to accept the Vice Presidency of an Eastern firm, his resignation becoming effective January 31.

L. W. Grothaus recently appointed to succeed C. E. Searle as general representative of the Allis-Chalmers Manufacturing Company, needs no introduction to the industries of power generation and utilization. He became affiliated with the Allis-Chalmers Manufacturing Company with the acquisition of the Bullock Electric Manufacturing Company, Norwood, Ohio, in 1904.

His appointment as General Representative became effective January 1, 1932.

At a meeting of the Board of Directors of the Westinghouse Electric International Company held in New York, January 27, George H. Bucher was elected vice president and general manager.

He will make his headquarters at 150 Broadway, New York, N. Y.

Edgar M. Moore & Company, Farmers Bank Building, Pittsburgh have been appointed District Representative for the American Transformer Company of Newark, N. J. This Company manufacturers a complete line of dry type transformers and are especially well known as designers and manufacturers of testing equipment and transformers for special applications.

WITH THE MANUFACTURERS

The Aluminum Company of America of Pittsburgh, Pa., are distributing a twenty page booklet entitled "Channeluminum Electrical Conductors of Alcoa Aluminum." The Booklet is well illustrated with drawings, photographs and tables and will be sent to interested parties on request.

The January issue of the "De Laval Centrifugal Review" is now available. This issue has several articles on oil purification and contains many photographs. Copies may be secured by writing the De Laval Separator Company, New York.

Special Bulletin No. 211 describes the new large Reliance Type T. Direct-current Motors. These motors range in size from 100 H.P., 200 R.P.M. to 350 H.P., 850 R.P.M. The bulletin includes details of construction, cross-sectional drawing, dimensions and table of ratings. It will be gladly sent to all who request it. Write Reliance Electric & Engineering Company, Cleveland, Ohio.

The winter issue of "Powerfax" published by the Elliott Company has been received. It is a 32 page

issue and has a list of very interesting articles which are illustrated with many photographs and drawings. Copy of this very interesting issue may be obtained by writing the Elliott Company, Jeannette, Pa.

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The January issue of the "Trumbull Cheer" published by the Trumbull Electric Manufacturing Company, has been received. One of the features of this issue is the address of Ex-Governor Trumbull to the members of the Trumbull organization. It is interesting to note that "Trumbull Cheer" will be twenty-five years old next April having been issued all this time without an interruption and out of over ten thousand registered house publications is the ninth oldest in the United States according to "Printers Ink." Copy of the January issue may be obtained by writing the Trumbull Electric Manufacturing Company, Plainville, Conn.

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The Ohio Electric Manufacturing Company, Cleveland, Ohio are distributing Bulletin No. 125. This bulletin is a special separation magnet bulletin. It is a 12 page bulletin and contains many photographs of installations and other valuable information. Copies may be obtained by writing the above company.

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"Reclamation of Electrical Oils" is the title of a new 16 page booklet just prepared by the S. F. Bowser & Co., Inc., Fort Wayne, Ind. It is an interesting review of insulating oil reclamation processes, together with a complete description of the Bowser Uni-Pass process and its advantages. The booklet is well illustrated and contains a schematized drawing, also a cross-section printed in color. Copies may be secured by interested parties by writing the above concern.

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Una Welding, Inc., of Cleveland, Ohio are distributing their new bulletin No. 140. It is a twenty page booklet and contains information on welding rods; description of welders and accessories. Copies may be obtained by interested parties.

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A new 30" size, heavy duty lifting magnet, is announced by Cutler-Hammer, Inc., 259 N. 12th St., Milwaukee, Wis. This new magnet is especially suitable for use with crawler type cranes in foundries, junk yards, warehouses, etc., where the size of the D.C. generator must be small and the lifting capacity of the magnet high. A 2½ K.W. generator is all that is required.

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OBITUARIES

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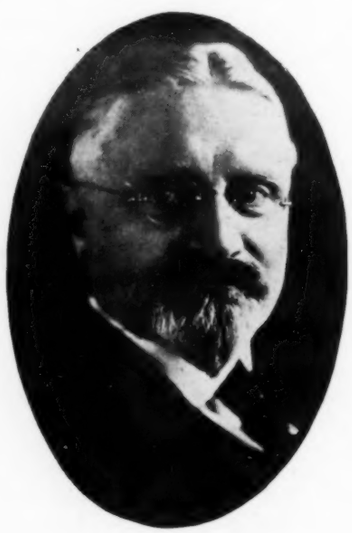
Frederick D. MacKay, 60, vice president of E. W. Bliss Company, Brooklyn, N. Y., manufacturer of rolling mill machinery and other equipment, died at his home in that city January 14.

J. E. Fries, one of the most prominent engineers of the South, died at Birmingham on January 23, after a long illness. For the past 16 years, Mr. Fries has been associated with the Tennessee Coal, Iron and Railroad Company at Birmingham, Ala. Born in Sweden and educated in that country, he graduated from the Royal Polytechnic Institute of Stockholm in Electrical Engineering and Mechanical Engineering in 1898.

He was with various concerns in Sweden till 1903 when be came to America. Before joining the Tennessee Company in 1916 Mr. Fries was with the Westinghouse, Church, Kerr Company, Allis Chalmers Company, Canadian General Electric Company, Crocker Wheeler Company. In 1916 he came to the Tennessee Coal, Iron and Railroad Company as Chief Electrical Engineer and in 1920 was made Chief Engineer which position he held until his death.



J. E. FRIES

Mr. Fries was an extremely active member of the Association of Iron and Steel Electrical Engineers. In 1919 he organized the Birmingham Section of the A. I. & S. E. E. and served as its first chairman. In his 16 years of active membership in the Association he has served as a director and on many National Committees. He assisted in an active capacity in the preparation and adoption of the A. I. & S. E. E. Standardized Mill Type Motor and at the time of his death was serving on the Standardization Committee.

Mr. Fries contributed several valuable papers to the Association Proceedings and his experiences, ideas and opinions as reflected in his discussions on other papers presented were always read by our members with care and interest. He was a member of several other engineering societies and took an active interest in all their activities.

The entire engineering fraternity sustained a great loss in the death of Mr. Fries and the membership of the Association extend their sympathies and condolences to the family, organization and associates of this nationally known engineer, our friend, co-worker and counselor.